CLAIMS:

What is claimed is:

1. A method for inspecting a sample, the method comprising:

illuminating at least a portion of a sample with an illumination beam to generate a reflected beam;

interfering a first reference beam and the reflected beam to generate an interference pattern;

recording the interference pattern;

comparing the recorded interference pattern with a comparison image to detect differences between the recorded interference pattern and the comparison image.

2. The method for inspecting a sample according to claim 1, wherein the comparing further comprises subtracting the recorded interference pattern from the comparison image.

3. The method for inspecting a sample according to claim 1, wherein the comparing further comprises subtracting the comparison image from the recorded interference pattern.

4. The method for inspecting a sample according to claim 1, wherein the sample comprises a portion of a wafer having a repeatable array of features.

5. The method for inspecting a sample according to claim 1, further comprising determining whether differences between the recorded interference pattern and the comparison image exceed a predetermined threshold.

6. The method for inspecting the sample according to claim 1, wherein the reference beam and the illumination beam have a common phase.

7. The method for inspecting the sample according to claim 1, wherein a component of the illumination beam the reference beam passes through a beam splitter, the component of the illumination beam comprising the reference beam.

8. The method for inspecting the sample according to claim 1, wherein the reference beam and the illumination beam have a common source.

9. The method for inspecting the sample according to claim 1, wherein the reference beam reflects from a beam splitter before interfering with the first image.

10. The method for inspecting the sample according to claim 1, wherein the sample includes High Aspect Ratio (HAR) structures.

11. The method for inspecting the sample according to claim 10, wherein the HAR structures have aspect ratios in the range of about 1:1 to about 12:1.

12. A method for inspecting a sample, the method comprising:

illuminating at least a portion of a sample with an illumination beam to generate a reflected beam;

interfering a first reference beam and the reflected beam to generate a first interference pattern;

recording the first interference pattern;

adjusting a phase of the illumination beam to adjust contrast between a first portion of the first interference pattern and a second portion of the first interference pattern.

13. The method for inspecting a sample according to claim 12, wherein the adjusting of the contrast provides optimal contrast between the first portion of the first interference pattern and the second portion of the first interference pattern.

14. The method for inspecting a sample according to claim 12, further comprising:

determining a first average intensity value for the first portion of the first interference pattern and a second average intensity value for the second portion of the first interference pattern;

determining a first interference pattern difference value based on the difference between the first and second average intensity values for the first interference pattern;

interfering a second reference beam and the reflected beam to generate a second interference pattern, the second reference beam having a different phase than the first reference beam;

determining a first average intensity value for a first portion of the second interference pattern and a second average intensity value for the second portion of the second interference pattern;

determining a second interference pattern difference value based on the difference between the first and second average intensity values for the second interference pattern;

wherein the adjusting the phase of the reference beam further comprises adjusting the phase of the reference beam based on the first and second interference pattern difference values.

15. The method for inspecting a sample according to claim 14, wherein the second reference beam and the first reference beam are 180 degrees out of phase with each other.

16. The method for inspecting a sample according to claim 14, wherein the adjusting the phase of the illumination beam further comprises adjusting the phase of the illumination beam based on a ratio of the first and second interference pattern difference values.

17. The method for inspecting a sample according to claim 12, further comprising

interfering a second reference beam and the reflected beam to generate a second interference pattern, the second reference beam having a different phase than the first reference beam;

wherein the adjusting the phase of the reference beam further comprises adjusting the phase of the reference beam based on at least portions of the first and second interference patterns.

18. The method for inspecting a sample according to claim 17, further comprising:

detecting the first interference pattern at a first detector;

detecting the second interference pattern at a second detector.

19. The method for inspecting a sample according to claim 17, wherein the first and second reference beams are polarized orthogonal to each other.

20. The method for inspecting a sample according to claim 17, wherein the first reference beam has a same phase as the illumination beam and the second reference beam is ninety degrees out of phase with the illumination beam.

21. The method for inspecting a sample according to claim 17, further comprising:

passing a component of the illumination beam passes through a first polarizing beam splitter, the component of the illumination beam having a polarization of about 45 degrees;

passing the component of the illumination beam through a second polarizing beam splitter to generate the first reference beam having a first polarization and an intermediate beam having a second polarization, the first and second polarizations being orthogonal to each other;

transmitting the intermediate beam through a phase retarder to generate the second reference beam, the second reference beam having a phase that substantially differs from the phase of the first reference beam.

22. The method for inspecting a sample according to claim 17, wherein the wherein the first and second reference beams are polarized orthogonal relative to each other, one of the first and second reference beams reflecting from a beam splitter before interfering with the reflected beam and the other of the first and second reference beams propagating through the beam splitter before interfering the with reflected beam.

23. The method for inspecting a sample according to claim 17, further comprising:

receiving a component of the illumination beam at a first polarizing beam splitter to generate the first reference beam having a first polarization and an intermediate beam having a second polarization, the first and second polarizations being orthogonal to each other;

passing the intermediate beam through a phase retarder to generate the second reference beam, the second reference beam having a phase that substantially differs from the phase of the first reference beam.

24. A method for inspecting a sample, the method comprising:

illuminating a sample with an illumination beam to generate a reflected beam, the sample comprising an array of spaced features, with a distance d between adjacent features;

laterally separating the reflected into first and second beams, the first and second beams being displaced from one another by a displacement distance equal to a multiple of the distance d, the second beam being about 180 degrees out of phase with the first beam;

interfering the first beam and the second beam to generate an interference pattern;

detecting the interference pattern.

25. The method for inspecting a sample according to claim 24, wherein the interfering further comprises interfering a reference beam with the first and second beams to generate the interference pattern.

26. The method for inspecting a sample according to claim 24, wherein the interfering further comprises division amplitude interference.

27. The method for inspecting a sample according to claim 24 wherein the interfering further comprises division amplitude interference through polarization.

28. The method for inspecting a sample according to claim 24, wherein the interfering further comprises division wavefront interference through Fourier filtering.

29. The method for inspecting a sample according to claim 24, wherein the interfering further comprises division wavefront interference.

30. The method for inspecting a sample according to claim 24 wherein the interfering further comprises using a Nomarski layout.

31. The method for inspecting a sample according to claim 24, wherein the interfering the first beam and the second subtracts the second beam from the first beam to form the interference image.

32. The method for inspecting a sample according to claim 19, wherein the displacement distance equals the distance d.

33. The method for inspecting a sample according to claim 19, wherein the displacement distance equals twice the distance d.

34. A method for inspecting a sample, the method comprising:

illuminating at least a portion of a sample with an illumination beam to generate a reflected beam;

interfering a first reference beam and the reflected beam to generate an interference pattern;

recording the interference pattern;

comparing the recorded interference pattern with a comparison image to detect differences between the recorded interference pattern and the comparison image;

adjusting a phase difference between the reflected beam and the first reference beam to adjust contrast between a first portion of the interference pattern and a second portion of the interference pattern.

35. The method for inspecting a sample according to claim 34, wherein the adjusting of the contrast provides optimal contrast between the first portion of the first interference pattern and the second portion of the first interference pattern.

36. The method for inspecting the sample according to claim 34, wherein the reference beam and the illumination beam have a common illumination source.

37. The method for inspecting the sample according to claim 34, wherein a component of the illumination beam the reference beam passes through a beam splitter, the component of the illumination beam comprising the reference beam.

38. The method for inspecting the sample according to claim 34, wherein the reference beam and the illumination beam have a common source.

39. The method for inspecting the sample according to claim 34, wherein the reference beam reflects from a beam splitter before interfering with the first image.

40. The method for inspecting a sample according to claim 34, further comprising:

determining a first average intensity value for the first portion of the first interference pattern and a second average intensity value for the second portion of the first interference pattern;

determining a first interference pattern difference value based on the difference between the first and second average intensity values for the first interference pattern;

interfering a second reference beam and the reflected beam to generate a second interference pattern, the second reference beam having a different phase than the first reference beam;

determining a first average intensity value for a first portion of the second interference pattern and a second average intensity value for the second portion of the second interference pattern;

determining a second interference pattern difference value based on the difference between the first and second average intensity values for the second interference pattern;

wherein the adjusting the phase of the illumination beam further comprises adjusting the phase of the illumination beam based on the first and second interference pattern difference values.

41. The method for inspecting a sample according to claim 40, further comprising

interfering a second reference beam and the reflected beam to generate a second interference pattern, the second reference beam having a different phase than the first reference beam;

wherein the adjusting the phase of the reference beam further comprises adjusting the phase of the reference beam based on at least portions of the first and second interference patterns.

42. The method for inspecting a sample according to claim 41, further comprising:

detecting the first interference pattern at a first detector;

detecting the second interference pattern at a second detector.

43. The method for inspecting a sample according to claim 41, wherein the first reference beam has a same phase as the illumination beam and the second reference beam is 180 degrees out of phase with the illumination beam.

44. The method for inspecting a sample according to claim 41, further comprising:

passing a component of the illumination beam passes through a first polarizing beam splitter, the component of the illumination beam having a polarization of about 45 degrees;

passing the component of the illumination beam through a second polarizing beam splitter to generate the first reference beam having a first polarization and an intermediate beam having a second polarization, the first and second polarizations being orthogonal to each other;

transmitting the intermediate beam through a phase retarder to generate the second reference beam, the second reference beam having a phase that substantially differs from the phase of the first reference beam.

45. A inspection apparatus for inspecting a sample, the apparatus comprising:

an illumination source for providing an illumination beam at the sample to generate a reflected beam;

a reference module for providing first and second reference beams, the first and second reference beams being out of phase with each other;

a first detector aligned to detect a first interference pattern generated by at least a component of the reflected beam and the first reference beam;

a second detector aligned to detect a second interference pattern generated by at least a component of the reflected beam and the second reference beam.

46. The inspection apparatus of claim 45, wherein the first and second reference beams differ in phase by 180 or 90 degrees.

47. The inspection apparatus of claim 45, further comprising a beam splitter for reflecting one component of the illumination beam at the sample and for permitting at least another

component of the illumination beam to pass through the beam splitter to the reference module.

48. The inspection apparatus of claim 45, wherein the reference module further comprises a phase retarder disposed along an optical path of one of the two reference beams.

49. The inspection apparatus of claim 45, wherein the reference module further comprises:

a first polarizing beam splitter for receiving at least a component of the illumination beam and separating the component of the illumination beam into the first reference beam and an intermediate beam;

a phase retarder for changing the phase of the intermediate beam to generate the second reference beam.

50. The inspection apparatus of claim 45, wherein the first and second reference beams are orthogonally polarized relative to each other.

51. The inspection apparatus of claim 45, further comprising one or more polarizing elements in optical paths of the illumination and reflected beams, to direct polarized light to the sample and to rotate polarization of the reflected beam so that it has equal intensity orthogonal optical components.

52. The inspection apparatus of claim 45, further comprising polarizing elements disposed along an optical path associated with the reflected beam for separating the reflected beam into first and second beams, the first and second beams being laterally separated and 180 degrees out of phase relative to each other.

53. The inspection apparatus of claim 52, wherein the polarizing elements further comprise a pair of aligned Wollaston prisms.

54. An inspection apparatus for inspecting a sample having an array of features, each of the features being separated by certain distance from an adjacent feature, the inspection apparatus comprising:

an illumination source for providing an illumination beam at the sample to generate a reflected beam;

a polarizing element positioned to receive the reflected beam and configured to separate the reflected beam into first and second beams, the first and second beams being laterally separated and 180 degrees out of phase relative to each other;

a first detector aligned to detect a first interference pattern generated by interference of the first and second beams.

55. The inspection apparatus of claim 54, further comprising a reference module for generating a first reference beam, the first reference beam interfering with the first and second beams at the first detector.

56. The inspection apparatus of claim 54, wherein the polarizing element comprises at least one Wollaston prism.

57. The inspection apparatus of claim 54, further comprising:

a reference module for generating first and second reference beams, the first reference beam interfering with the first and second beams at the first detector;

a second detector aligned to detect a second interference pattern generated by interference of the first beam, the second beam, and the second reference beam.